

AMENDMENTS TO THE CLAIMS

Please cancel claims 12, 16 and 29, add claims 34-36 and amend the claims as follows:

1. (Currently Amended) A method for depositing a copper seed layer onto a substrate surface, ~~wherein the substrate surface comprises~~ containing a barrier layer, comprising:

~~placing~~ exposing the substrate surface ~~into to~~ to a copper solution, ~~wherein the copper solution comprises~~ containing complexed copper ions and having a pH value of less than 7, wherein the complexed copper ions are derived from a copper source selected from the group consisting of copper citrate, copper borate, copper tartrate, copper oxalate, derivatives thereof, and combinations thereof;

applying an electrical bias ~~to~~ across the substrate surface; and

reducing the complexed copper ions with the electrical bias to deposit the copper seed layer onto the barrier layer.

2. (Currently Amended) The method of claim 1, wherein the barrier layer is comprises a material selected from the group consisting of cobalt, ruthenium, nickel, tungsten, tungsten nitride, titanium, titanium nitride, and silver.

3. (Currently Amended) The method of claim ~~1~~ 2, wherein the ~~complexed copper source is~~ ions are selected from the group consisting copper citrate, ~~copper borate, copper tartrate, copper oxalate, copper pyrophosphate, copper acetate, copper EDTA complex and combinations thereof.~~

4. (Currently Amended) The method of claim 3, wherein the copper solution contains a concentration of complexed copper ions ~~have a concentration within the~~ range from about 0.02 M to about 0.8 M.

5. (Currently Amended) The method of claim 4, wherein the electrical bias is ~~configured to generate~~ a current density across the substrate surface that is of less than about 10 mA/cm² across the substrate surface.

6. (Currently Amended) The method of claim 5, wherein the current density is within the range from about 0.5 mA/cm² to about 3 mA/cm².

7. (Currently Amended) The method of claim 6, wherein the copper seed layer has a thickness of less than about 200 Å.

8. (Currently Amended) The method of claim 7, further comprising depositing a copper gap-fill copper layer onto the copper seed layer and wherein, depositing the gap-fill layer comprises, by:

placing exposing the substrate surface ~~into~~ to a second copper solution, wherein the second copper solution includes containing free-copper ions; and

applying a second electrical bias ~~to~~ across the substrate surface; ~~and reducing the free-copper ions with the second electrical bias to deposit the copper gap-fill layer onto the copper seed layer.~~

9. (Currently Amended) The method of claim 8, further comprising depositing a copper bulk-fill copper layer onto the copper gap-fill layer, wherein depositing the bulk-fill layer comprises, by:

placing exposing the substrate surface ~~into~~ to a third copper solution, wherein third copper solution includes the containing free-copper ions; and

applying a third electrical bias ~~to~~ across the substrate surface; ~~and reducing the free-copper ions with the third electrical bias to deposit the copper bulk-fill layer onto the copper gap-fill layer.~~

10. (Original) The method of claim 9, wherein at least one leveling agent is added to the second copper solution to form the third copper solution.

11. (Currently Amended) A method for depositing a metal seed layer onto a barrier layer on a substrate surface, comprising:

~~placing the exposing a substrate surface into to a complexed copper solution;~~
~~wherein the solution is acidic and comprises a metal source compound and a complexing compound~~ containing complexed copper ions derived from a copper source selected from the group consisting of copper citrate, copper borate, copper tartrate, copper oxalate, derivatives thereof and combinations thereof;

~~forming complexed metal ions within the solution; and~~

~~reducing the complexed metal~~ copper ions with an electroplating technique to form ~~the metal~~ a copper seed layer.

12. (Cancelled)

13. (Currently Amended) The method of claim 12, wherein the barrier layer is contains a material selected from the group consisting of cobalt, ruthenium, nickel, tungsten, tungsten nitride, titanium, titanium nitride, and silver.

14. (Currently Amended) The method of claim ~~12~~ 13, wherein the ~~complexed metal ions are selected from the group consisting metal~~ copper source is copper citrates, metal borates, metal tartrates, metal oxalates, metal pyrophosphates, metal acetates, metal EDTA complexes and combinations thereof.

15. (Currently Amended) The method of claim ~~14~~ 11, wherein the ~~metal copper source compound~~ has a ~~metal~~ copper concentration within the range from about 0.02 M to about 0.8 M.

16. (Cancelled)

17. (Currently Amended) The method of claim 14, wherein ~~the electroplating technique comprises a bias configured to generates~~ a current density that is of less than about 10 mA/cm² across the substrate surface during the electroplating technique.

18. (Currently Amended) The method of claim 17, wherein the current density is within the range from about 0.5 mA/cm² to about 3 mA/cm².

19. (Currently Amended) The method of claim 18, wherein the ~~metal~~ copper seed layer has a thickness of less than about 200 Å.

20. (Currently Amended) The method of claim 19, further comprising depositing a copper gap-fill ~~copper~~ layer ~~onto the metal seed layer and wherein, depositing the gap-fill layer comprises, by:~~

~~placing exposing the substrate surface into to a first copper solution, wherein the copper solution includes containing free-copper ions; and~~

~~applying a second electrical bias to across the substrate surface; and reducing the free-copper ions with the second electrical bias to deposit the copper gap-fill layer onto the metal copper seed layer.~~

21. (Currently Amended) The method of claim 20, ~~wherein~~ further comprising depositing the a copper bulk-fill ~~copper~~ layer ~~onto the copper gap-fill layer comprises, by:~~

~~placing exposing the substrate surface into to a second copper solution, wherein second copper solution includes the containing free-copper ions; and~~

~~applying a third electrical bias across the substrate surface; and reducing the free-copper ions with the third electrical bias to deposit the copper bulk-fill layer onto the copper gap-fill layer.~~

22. (Currently Amended) The method of claim 21, wherein at least one leveling agent is added to the first copper solution to form the second copper solution.

23. (Currently Amended) A method for electroplating a copper seed layer ~~to a barrier layer from a copper solution~~, comprising:

~~placing exposing~~ a substrate surface ~~comprising the~~ containing a barrier layer into fluid contact with the copper solution, wherein the to a complexed copper solution ~~comprises~~ containing complexed copper ions and ~~complexing compounds~~ derived from a copper source selected from the group consisting of copper citrate, copper borate, copper tartrate, copper oxalate, derivatives thereof and combinations thereof; and

reducing the complexed copper ions with an electrical bias to form the copper seed layer.

24. (Currently Amended) The method of claim 23, wherein the barrier layer is contains a material selected from the group consisting of cobalt, ruthenium, nickel, tungsten, tungsten nitride, titanium, titanium nitride, and silver.

25. (Currently Amended) The method of claim 23 24, wherein the ~~copper solution~~ comprises at least one copper source compound selected from the group consisting is copper citrate, ~~copper borate, copper tartrate, copper oxalate, copper pyrophosphate, copper acetate, copper EDTA complex and combinations thereof.~~

26. (Currently Amended) The method of claim 24, wherein the electrical bias is ~~configured to generate~~ a current density of less than about 10 mA/cm² across the a substrate surface.

27. (Currently Amended) The method of claim 26, wherein the current density is within the range from about 0.5 mA/cm² to about 3 mA/cm².

28. (Currently Amended) The method of claim 14 25, wherein the complexed copper solution has a copper ions have a metal concentration within the range from about 0.02 M to about 0.8 M.

29. (Cancelled)

30. (Currently Amended) The method of claim 27 28, wherein the copper seed layer has a thickness of less than about 200 Å.

31. (Currently Amended) The method of claim ~~30~~ 23, further comprising depositing a copper gap-fill ~~copper~~ layer ~~onto the copper seed layer and wherein, depositing the gap-fill layer comprises, by:~~

~~placing exposing the substrate surface into to a second copper solution, wherein the second copper solution includes containing free-copper ions; and~~

~~applying a second bias across the a substrate surface; and reducing the free-copper ions with the second bias to deposit the copper gap-fill layer onto the copper seed layer.~~

32. (Currently Amended) The method of claim 31, ~~wherein further comprising depositing a copper bulk-fill copper layer onto the copper gap-fill layer comprises, by:~~

~~placing exposing the substrate surface into to a third copper solution, wherein third copper solution includes the containing free-copper ions; and~~

~~applying a third bias across the substrate surface; and reducing the free-copper ions with the third bias to deposit the copper bulk-fill layer onto the copper gap-fill layer.~~

33. (Original) The method of claim 32, wherein at least one leveling agent is added to the second copper solution to form the third copper solution.

34. (New) The method of claim 4, wherein the pH value is within a range from about 4.5 to about 6.5.

35. (New) The method of claim 19, wherein the complexed copper solution has a pH value within a range from about 4.5 to about 6.5.

36. (New) The method of claim 23, wherein the complexed copper solution has a pH value within a range from about 4.5 to about 6.5.